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CLAIMS

1. A telemetry receiver system for detecting a signal, said telemetry receiver system comprising:

5 (a) a transformer which measures a modulated signal current created in a drill string; and

(b) a current receiver cooperating with said transformer
(i) to measure a response signal induced in said transformer by said modulated signal current, and

10 (ii) to demodulate said response signal to obtain said signal.

2. The telemetry receiver system of claim 1 wherein said transformer comprises a toroid transformer surrounding said drill string.

15 3. The telemetry receiver system of claim 1 comprising a plurality of said transformers, wherein:

(a) at least one of said plurality of transformers comprises a toroid transformer surrounding said drill string;

(b) at least one said plurality of transformers comprises a toroid transformer
20 disposed on a rig operating said drill string; and

(c) outputs from said plurality of transformers are combined to yield said signal with an enhanced signal to noise ratio.

4. The telemetry receiver system of claim 1 further comprising an rig voltage
25 receiver, wherein:

(a) said rig voltage receiver measures a modulated voltage signal resulting from said modulated signal current; and

(b) output of said rig voltage receiver and said current receiver are combined to yield said signal with an enhanced signal to noise ratio.

30 5. The telemetry receiver system of claim 1 wherein:

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(a) said transformer is disposed in an annulus defined by a wall of a borehole and an outside diameter of casing;

(b) said current receiver is disposed at the surface of the earth; and

(c) said transformer and said receiver are operationally connected by means of a communication link.

6. The telemetry receiver system of claim 1 wherein said transformer is disposed underwater at a location proximate where said drill string enters a borehole.

7. The telemetry receiver system of claim 1 wherein said transformer is disposed around casing encompassing a drill string operating through a template, wherein said template incorporates at least one completed well.

8. The telemetry receiver system of claim 1 wherein said response signal is a voltage.

9. The telemetry receiver system of claim 1 wherein said response signal is a current.

10. A measurement-while-drilling telemetry system comprising:

(a) a transmitter disposed within a downhole assembly, wherein said transmitter creates a modulated signal current in a drill string; and

(b) a telemetry receiver system comprising

(i) a transformer which measures said modulated signal current, and

(ii) a current receiver cooperating with said transformer

to measure a response signal induced in said transformer by said signal current, and

to demodulate said response signal to yield a signal from said transmitter.

11. The telemetry system of claim 10 wherein said transformer comprises a toroid transformer surrounding said drill string.

12. The telemetry system of claim 10 wherein said telemetry receiver system
5 comprises a plurality of said transformers, wherein:

(a) at least one of said plurality of transformers comprises a toroid transformer surrounding said drill string;

(b) at least one said plurality of transformers comprises a toroid transformer disposed on a rig operating said drill string; and

10 (c) outputs from said plurality of transformers are combined to yield said signal with an enhanced signal to noise ratio.

13. The telemetry system of claim 10 further comprising a rig voltage receiver, wherein:

15 (a) said rig voltage receiver measures a modulated voltage signal resulting from said modulated signal current; and

(b) output of said rig voltage receiver and said current receiver are combined to yield said signal with an enhanced signal to noise ratio.

20 14. The telemetry system of claim 10 wherein said response signal is a voltage.

15. The telemetry system of claim 10 wherein said response signal is a current.

16. A MWD system comprising:

25 (a) a downhole assembly which terminates a lower end of a drill string, wherein said downhole assembly comprises

(i) a sensor, and

(ii) a transmitter, wherein said transmitter creates a modulated signal current in said drill string which is indicative of a response of said sensor to a parameter
30 of interest; and

(b) a telemetry receiver system comprising

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- (i) a transformer which measures said modulated signal current, and
- (ii) a current receiver cooperating with said transformer, wherein said current receiver measures a response signal induced in said transformer by said signal current, and demodulates said response signal to yield said response of said sensor.

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17. The MWD system of claim 16 wherein said transformer comprises a toroid transformer surrounding said drill string.

18. The MWD system of claim 16 further comprising surface equipment for
10 converting said response of said sensor into said parameter of interest.

19. The MWD system of claim 16 wherein said telemetry receiver system comprises a plurality of said transformers, wherein:

(a) at least one of said plurality of transformers comprises a toroid transformer
15 surrounding said drill string;

(b) at least one said plurality of transformers comprises a toroid transformer disposed on a rig operating said drill string; and

(c) outputs from said plurality of transformers are combined with a processor in surface equipment to yield said response of said sensor with an enhanced signal to
20 noise ratio.

20. The MWD system of claim 16 further comprising an rig voltage receiver, wherein:

(a) said rig voltage receiver measures a modulated voltage signal resulting
25 from said modulated signal current; and

(b) output of said rig voltage receiver and said current receiver are combined to yield said response of said sensor with an enhanced signal to noise ratio.

21. The MWD system of claim 16 wherein said response signal is a voltage.

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22. The MWD system of claim 16 wherein said response signal is a current.

23. A method for receiving a signal produced by an electromagnetic telemetry system, the method comprising:

5 (a) detecting, with a transformer, a modulated signal current created in a drill string by measuring a response signal induced in said transformer by said modulated signal current; and

(b) demodulating said response signal with a current receiver cooperating with said transformer thereby receiving said signal.

10 24. The method of claim 23 wherein said transformer comprises a toroid transformer surrounding said drill string.

25. The method of claim 23 comprising the additional steps of:

15 (a) providing a plurality of said transformers, wherein
(i) at least one of said plurality of transformers comprises a toroid transformer surrounding said drill string, and

(ii) at least one said plurality of transformers comprises a toroid transformed disposed on a rig operating said drill string; and

20 (b) combining outputs from said plurality of transformers to receive said signal with an enhanced signal to noise ratio.

26. The method of claim 23 further comprising the additional steps of:

(a) providing a rig voltage receiver;

25 (b) measuring, with said rig voltage receiver, a modulated voltage resulting from said modulated signal current; and

(c) combining output of said rig voltage receiver and output of said current receiver to receive said signal with an enhanced signal to noise ratio.

30 27. The method of claim 23 comprising the additional steps of:

(a) disposing said transformer in an annulus defined by a wall of a borehole and an outside diameter of casing;

(b) disposing said current receiver remote from said transformer; and

(c) operationally connecting said transformer and said current receiver by means of a communication link.

28. The method of claim 23 further comprising disposing said transformer underwater at a location proximate where said drill string enters a borehole.

10 29. The method of claim 23 further comprising disposing said transformer on a casing encompassing a drill string that is operating through a template, wherein said template incorporates at least one completed well.

30. The method of claim 23 wherein said response signal is a voltage.

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31. The method of claim 23 wherein said response signal is a current.

32. A method for telemetering a signal from a downhole assembly to an uphole location while drilling a borehole, the method comprising:

20 (a) disposing an electromagnetic transmitter within said downhole assembly, wherein said transmitter creates a modulated signal current in a drill string operationally connected to said downhole assembly;

(b) disposing a telemetry receiver system uphole from said downhole assembly, said telemetry receiver system comprising

25 (i) a transformer which measures said modulated signal current, and
(ii) a current receiver cooperating with said transformer;

(c) with said current receiver, measuring a response signal induced in said transformer by said signal current; and

30 (d) with said current receiver, demodulating said response signal to yield said signal.

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33. The method of claim 32 wherein said transformer comprises a toroid transformer surrounding said drill string.

34. The method of claim 32 comprising the additional steps of:

5 (a) providing said telemetry receiver system with a plurality of said transformers, wherein

(i) at least one of said plurality of transformers comprises a toroid transformer surrounding said drill string, and

10 (ii) at least one said plurality of transformers comprises a toroid transformer disposed on a rig operating said drill string; and

(b) combining outputs from said plurality of transformers to yield said signal with an enhanced signal to noise ratio.

35. The method of claim 32 comprising the additional steps of:

15 (a) providing said telemetry receiver system with a rig voltage receiver, wherein said rig voltage receiver measures a modulated voltage signal induced by said modulated signal current; and

(b) combining outputs of said rig voltage receiver and said current receiver to yield said signal with an enhanced signal to noise ratio.

20 36. The method of claim 32 wherein said response signal is a voltage.

37. The method of claim 32 wherein said response signal is a current.

25 38. A method for measuring a parameter of interest while drilling a borehole, the method comprising:

(a) providing a downhole assembly that terminates a lower end of a drill string, wherein said downhole assembly comprises

(i) a sensor, and

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(ii) a transmitter, wherein said transmitter creates a modulated signal current in a drill string which is indicative of a response of said sensor to said parameter of interest;

(b) providing a telemetry receiver system comprising

(i) a transformer which measures said modulated signal current, and

(ii) a current receiver cooperating with said transformer;

(c) measuring, with said current receiver, a response signal induced in said transformer by said signal current;

(d) demodulating with said current receiver said response signal to yield said response of said sensor, and

(e) transforming said response of said sensor into a measure of said parameter of interest.

39. The method of claim 38 wherein said transformer comprises a toroid transformer surrounding said drill string.

40. The method of claim 38 further comprising the steps of:

(a) providing surface equipment which cooperates with said current receiver; and

(b) converting said response signal into said parameter of interest using said surface equipment.

41. The method of claim 38 wherein:

(a) said telemetry receiver system comprises a plurality of said transformers;

(b) at least one of said plurality of transformers comprises a toroid transformer surrounding said drill string;

(c) at least one said plurality of transformers comprises a toroid transformer disposed on a rig operating said drill string; and

(d) outputs from said plurality of transformers are combined with a processor in said surface equipment to yield a measure of said parameter of interest with an enhanced signal to noise ratio.

42. The method of claim 40 further comprising:

(a) providing said telemetry receiver with a rig voltage receiver;

5 (b) measuring, with said rig voltage receiver, a modulated voltage signal induced by said modulated signal current; and

(c) combining outputs of said rig voltage receiver and said current receiver with a processor in said surface equipment to obtain a measure of said parameter of interest with an enhanced signal to noise ratio.

10 43. The method of claim 38 wherein said response signal is a voltage.

44. The method of claim 38 wherein said response signal is a current.

15 45. A method for measuring a parameter of interest while drilling a borehole, the method comprising:

(a) providing a downhole assembly that terminates a lower end of a drill string, wherein said downhole assembly comprises

(i) a sensor, and

20 (ii) a transmitter, wherein said transmitter creates a modulated signal current in a drill string which is indicative of a response of said sensor to said parameter of interest;

(b) providing a telemetry receiver system comprising

(i) a transformer which measures said modulated signal current, and

(ii) a receiver cooperating with said transformer;

25 (c) with said sensor inactive, measuring with said receiver a noise response signal induced in said transformer by said signal current;

(d) with said sensor activated, measuring with said receiver a signal plus noise response signal induced in said transformer by said signal current;

30 (e) combining said noise response signal with said signal plus noise response signal to obtain said response of said sensor; and

(f) transforming said response of said sensor into a measure of said parameter of interest.

46. The method of claim 45 further comprising the additional step of analyzing said noise response signal to determine optimum conditions under which to measure said signal plus noise response signal.

47. The method of claim 45 wherein said noise response signal and said signal plus noise response signal are voltages.

48. The method of claim 45 wherein said noise response signal and said signal plus noise response signal are currents.

49. A telemetry receiver system for detecting a signal, said telemetry receiver system comprising:

(a) a toroid which measures a modulated signal current created in a drill string, wherein said toroid surrounds casing encompassing said drill string; and

(b) a current receiver cooperating with said toroid

(i) to measure a response signal induced in said toroid by said modulated signal current, and

(ii) to demodulate said response signal to obtain said signal.

50. The telemetry receiver system of claim 49 wherein:

(a) said toroid is disposed in an annulus defined by a wall of a borehole and an outside diameter of said casing;

(b) said current receiver is disposed at the surface of the earth; and

(c) said toroid and said receiver are operationally connected by means of a communication link.

51. The telemetry receiver system of claim 49 wherein said toroid is disposed underwater at a location proximate where said casing enters a borehole.

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52. The telemetry receiver system of claim 49 wherein said toroid is disposed around casing encompassing a drill string operating through a template, wherein said template incorporates at least one completed well.

5 53. A measurement-while-drilling telemetry system comprising:

(a) a transmitter disposed within a downhole assembly operationally attached to a drill string operated by a rig, wherein said transmitter creates a modulated signal current in said drill string; and

(b) a telemetry receiver system comprising

10 (i) a toroid which measures said modulated signal current, and

(ii) a current receiver cooperating with said toroid

to measure a response signal induced in said toroid by said signal current, and

to demodulate said response signal to yield a signal from

15 said transmitter; wherein

(c) said toroid is located remote from said rig to optimize said signal with respect to noise.

20 54. A method for receiving a signal produced by an electromagnetic telemetry system, the method comprising:

(a) detecting, with a toroid surrounding casing in which a drill string is disposed, a modulated signal current created in said drill string by measuring a response signal induced in said toroid by said modulated signal current; and

25 (b) demodulating said response signal with a current receiver cooperating with said toroid thereby receiving said signal.

55. The method of claim 54 comprising the additional steps of:

(a) disposing said toroid in an annulus defined by a wall of a borehole and an outside diameter of said casing;

30 (b) disposing said current receiver at the surface of the earth; and

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(c) operationally connecting said toroid and said receiver by means of a communication link.

56. The method of claim 54 comprising the additional step of disposing said toroid
5 underwater at a location where said casing enters a borehole.

57. The method of claim 54 comprising the additional step of disposing said toroid
around casing encompassing a drill string operating through a template, wherein said
template incorporates at least one completed well.

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58. A method for telemetering a signal from a downhole assembly to an uphole
location while drilling a borehole:

(a) disposing a transmitter within a downhole assembly operationally attached
to a drill string operated by a rig, wherein said transmitter creates a modulated signal
15 current in said drill string;

(b) providing a telemetry receiver system comprising

(i) a toroid which measures said modulated signal current, and

(ii) a current receiver cooperating with said toroid

20 to measure a response signal induced in said toroid by said
modulated signal current, and

to demodulate said response signal to yield said signal from
said transmitter; and

(c) locating said toroid remote from said rig to optimize said signal with
respect to noise.

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